Chapter 4
Morphologic Abnormalities of Bone Marrow Elements

ABSTRACT

The diagnostic pathway starts with a thorough morphologic examination that should systematically evaluate every element of the bone marrow, make a differential count on smears and meticulously find and describe any abnormality. The information obtained will direct other diagnostic tracks. During this preliminary evaluation, any physiological factors should be considered, such as age. An anomaly of any marrow elements should raise an inquiry of its probable etiologies, not ignoring rare causes. A disease-specific abnormality should alert the search for other disease criteria and possible alternatives. An adequate experience with the pathology of hemopoietic disorders is necessary to anticipate their effects and search for any hidden diagnostic evidence. Careful attention to artifacts that could confuse morphologic interpretation and may lead to serious misdiagnosis is a critical consideration. This chapter discusses the typical abnormalities of bone marrow elements with some illustrations and possible etiologies.

INTRODUCTION

A thorough examination of good-quality bone marrow cytology and biopsy sections is critical for an accurate diagnosis. It requires deep knowledge and experience of the typical morphologic spectrum and the range of morphologic abnormalities that make the basis for morphologic diagnosis.

Aspirate and biopsy specimens are sometimes separately examined and reported, disrupting proper interpretation. Both specimens are complementary; cytology is ideal for fine cellular details and differential counting and is sometimes sufficient to make a preliminary diagnosis, e.g., in MDS and many reactive marrow conditions, often missed without a marrow smear or touch imprint examination.

Specific findings such as marrow cellularity, architecture, focal lesion or fibrosis, and other stromal elements are unique to biopsy examination.

The specific topography of different hemopoietic lineages is only appreciated in a biopsy section and is sometimes diagnostic, e.g., the presence of ALIP and detection of dysplastic architectural features like para-trabecular location of megakaryocytes in MDS. Infectious agents are easier to detect in biopsy sections and sometimes provide the only available clue, especially in chronic cases and immunocompromised patients.

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Besides, the biopsy allows a more comprehensive view of infiltration and hemopoietic regeneration by volume.

The main objectives of this chapter are to:

1. Describe the common morphologic abnormalities in individual marrow elements
2. Recognize common artifacts in morphologic examination

ABNORMALITIES OF BONE MARROW ELEMENTS

An abnormal morphology could signify a specific pathology, e.g., maturation abnormality, a hemoparasite, hemophagocytosis, or a general inflammatory reaction, such as a granulocytic shift to the left. Sometimes the abnormality is pathognomonic, such as hairy cells or a para-trabecular lymphoid infiltrate suggesting a follicular lymphoma, which suggests the necessary confirmatory tests to confirm the diagnosis. If non-diagnostic, a correlation with other data, follow-up, or a more comprehensive ancillary panel is necessary to reach a definite diagnosis.

The correlation between aspirate and biopsy specimens is an essential CAP quality measure for bone marrow examination and reporting. (Montero, 2021).

BONE MARROW CELLULARITY

Cellularity estimation within the clinical context helps guide the differential diagnosis of various disease categories. The marrow cellularity in healthy adults ranges from 48 to 79%. A quantitative assessment of cellularity is unreliable in bone marrow aspirate, given its tendency to form particles of variable size and the uncontrollable dilution factor with peripheral blood reaching 40-100% in bone marrow samples of 0.25-0.5 ml. The undisturbed whole tissue in biopsy sections provides a more accurate assessment.

Cellularity varies with physiological changes; adults have only a smaller proportion of the medullary space occupied by hematopoietic tissue. Children have active hemopoiesis through most of the medullary space: Similarly, the proportion of fat cells within the cellular marrow decreases gradually with age ranging from 59-95% in children less than ten years, have a mean of 50% at age 30, and about 30% at age 70, with sternal samples generally less cellular.

Figure 1 demonstrates varying cellularity degrees in bone marrow aspirates and biopsies.